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ABSTRACT

The United States Training and Employment Service General Aptitude Test Battery (GATB), first published in 1947, has been included in a continuing program of research to validate the tests against success in many different occupations. The GATB consists of 12 tests which measure nine aptitudes: General Learning Ability; Verbal Aptitude; Numerical Aptitude; Spatial Aptitude; Form Perception; Clerical Perception; Motor Coordination; Finger Dexterity; and Manual Dexterity. The aptitude scores are standard scores with 100 as the average for the general working population, and a standard deviation of 20. Occupational norms are established in terms of minimum qualifying scores for each of the significant aptitude measures which, when combined, predict job performance. Cutting scores are set only for those aptitudes which aid in predicting the performance of the job duties of the experimental sample. The GATB norms described are appropriate only for jobs with content similar to that shown in the job description presented in this report. A description of the validation sample is included. (AG)

ED 059286

TECHNICAL REPORT

ON

STANDARDIZATION OF THE GENERAL APTITUDE TEST BATTERY

FOR

CHEMIST, ASSISTANT (profess. & kin.) 0-50.22

S-7 (Formerly B-211)

U.S. DEPARTMENT OF HEALTH,
EDUCATION & WELFARE
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U. S. Employment Service in
Cooperation with
California and Michigan State Employment Services

U. S. DEPARTMENT OF LABOR
Bureau of Employment Security
Washington 25, D. C.
April 1960

GATB #612 and 174
July 1946 and May 1950

STANDARDIZATION OF THE GENERAL APTITUDE TEST BATTERY FOR CHEMIST, ASSISTANT 0-50.22

S-7

Summary

The General Aptitude Test Battery, B-1001, was administered to two samples of Chemist, Assistants 0-50.22. The table below shows for each sample, the year in which data collection was completed, the number included in the final sample, and the type of criterion used for validation purposes.

Sample	State	Year	N	Criterion
I	California	1946	82	Supervisory Ratings
II	Michigan	1950	36	Supervisory Ratings

Data for the two samples were analyzed separately and in combination. On the basis of the statistical and qualitative analysis of the data, Aptitudes G-Intelligence, V-Verbal Aptitude, N-Numerical Aptitude, and S-Spatial Aptitude were selected for inclusion in the test norms.

GATB Norms for Chemist, Assistant 0-50.22 S-7

Table I shows, for B-1001 and B-1002, the minimum acceptable score for each aptitude included in the test norms for Chemist, Assistant 0-50.22.

TABLE I

Minimum Acceptable Scores on B-1001 and B-1002 for S-7

B-1001			B-1002		
Aptitude	Tests	Minimum Acceptable Aptitude Score	Aptitude	Tests	Minimum Acceptable Aptitude Score
G	CB-1-H CB-1-I CB-1-J	115	G	Part 3 Part 4 Part 6	110
V	CB-1-H	110	V	Part 4	110
N	CB-1-D CB-1-I	110	N	Part 2 Part 6	105
S	CB-1-F CB-1-H	105	S	Part 3	100

Effectiveness of Norms

The data in Table IV-C indicate that 17 of the 34 poor workers, or 50 percent of them, did not achieve the minimum scores established as cutting scores on the recommended test norms. This shows that 50 percent of the poor workers would not have been hired if the recommended test norms had been used in the selection process. Moreover, 61 of the 78 workers who made qualifying test scores, or 78 percent, were good workers.

TECHNICAL REPORT

I. Problem

This study was conducted to determine the best combination of aptitudes and minimum scores to be used as norms on the General Aptitude Test Battery for the occupation of Chemist, Assistant 0-50.22

II. Sample

This study is based on two samples of Chemist, Assistants 0-50.22 employed at Shell Development Company, Emeryville, California and Polymer Corporation, Sarnia, Ontario, Canada. The test norms were developed on the basis of the results of both samples.

Sample I - California

The GATB, B-1001, was administered in July 1946 to 82 workers (39 males and 43 females) employed as Chemist, Assistant 0-50.22 at the Shell Development Company, Emeryville, California. The sample group included all employees on this job in the company; 38 Junior Laboratory Assistants and 44 Laboratory Assistants. Applicants for the job are selected primarily on the basis of education. They must have graduated from high school, have completed the study of high school chemistry, and have indicated during their interview a definite interest in chemistry, laboratory work, and scientific method. On-the-job training was given.

Sample II - Michigan

The GATB, B-1001, was administered in May 1950 to 36 female workers employed as Chemist, Assistant 0-50.22 at the Polymer Corporation, Sarnia, Ontario. The sample group included all employees who were available for testing out of a total 45. The 36 workers were employed as follows: 18 in the Gas Laboratory, 2 in the Investigational Laboratory, 4 in the Physical Laboratory, and 12 in the Analytical Laboratory; all known as Chemist Assistant (Synthetic Rubber). On-the-job training was given.

Table II shows the means, standard deviations, ranges and Pearson product-moment correlations with the criterion for age, education, and experience for each sample and for the Combined Sample.

TABLE II

Number of Workers in Sample (N), Means (M), Standard Deviations (σ), Ranges, and Pearson Product-Moment Correlations (r) with the Criterion for Age, Education, and Experience

Chemist Assistant 0-50.22

	N	M	σ	Range	r
Age (years)					
Sample I - California	82	26.4	4.9	19-46	.106
Sample II - Michigan	36	21.4	2.0	17-24	.245
Combined Sample	118	24.9	4.8	17-46	
Education (years)					
Sample I - California	82	14.4	1.5	12-19	-.160
Sample II - Michigan	36	12.0	.33	11-13	.166
Combined Sample	118	13.7	1.7	11-19	
Experience (months)					
Sample I - California	82	21.5	23.0	0-120	.202
#Sample II - Michigan	36	34.7	25.8	5-118	.233
##Combined Sample	118	25.5	24.6	0-120	

#N = 35
##N = 117

The data in Table II indicate that there are no significant correlations between age, education, or experience and the criterion for either of the two samples.

III. Job Descriptions

Job Title: Chemist, Assistant 0-50.22

Sample I - California
Job Summary: Determines percentage composition, presence or amount of specific compounds or elements, or measures physical constants of a variety of chemical compounds (liquid, solid, or gaseous), using standard laboratory techniques and equipment in accordance with detailed methods and prescribed procedures for the problem to which assigned, to aid research chemists in the development of industrial chemicals and the standardization of laboratory processes on an industrial production level.

Work Performed: Receives work assignment from Senior Laboratory Assistant, Junior Chemist or Chemist in the form of a work slip indicating type of analysis or measurement to be performed on a particular sample of a chemical compound.

Prepares work sample by measuring out samples of material to be analyzed either by pipetting, spatulating, filling an ampoule or by drawing a gas sample in a gas sample tube. Determines weight using a chemical balance, or by means of

density-volume relationships or measures the volume of a gas sample by use of suitable evacuated glass tubes which are filled with gas at atmospheric pressures.

Completes reaction by measuring out and combining with the sample the necessary reagents required in the method prescribed for the problem. Performs such operations as distilling, refluxing, igniting, agitating, stirring, cooling, or combustion of the sample in order to carry reaction through to completion.

Makes determination after reaction has been completed by determining amount of reagent or sample used in the reaction by titration (using a titrometer), by direct weighing of dried precipitate, by comparing color of final solution with a standard known solution in an electrical colorimeter, or by determining the acidity of the solution by titration (potentiometric) against a known standard solution. In the case of a problem involving measurement of a physical constant rather than the presence, absence or amount of a given element or compound, places sample to be measured in electrically controlled, heated or cooled baths, using such equipment as a refractometer, or other equipment as indicated in the methods instructions, and records such dial, thermometer, balance, or gage readings as are necessary to obtain data for calculations.

Makes calculations by inserting data recorded in laboratory workbook during sampling, reaction and determination steps in equations given in method outline and performs necessary calculations with the aid of slide rule, logarithm tables or calculating machine.

Completes problem by disassembling and cleaning equipment. Returns unused sample material to proper box on sample shelves in Coordination Section. Delivers work request and laboratory notebook to Senior Laboratory Assistant or Junior Chemist for checking and recording of results of analysis or determination report.

Occasionally fabricates or shapes simple, glass laboratory equipment: As needed in setting up equipment or preparation of such items of equipment as ampoules for sampling of volatile liquids, blows or shapes sample containers, seals glass bombs for ignition reactions, and bends and shapes glass tubing, using blow-torches, bunsen burners and assorted sizes and shapes of glass tubing.

Occasionally prepares special concentration of reagents as needed in a given method: Obtains required chemicals from Stock Room and dissolves or mixes chemicals in proper proportions to obtain desired concentration. Standardizes reagent by titration or other suitable means as indicated in the method outline.

Sample II - Michigan

Job Summary: Works in gas, investigational, physical, or analytical laboratory performing routine analyses of bydrocarbon gas, liquid, and mixtures by employing low temperature distillation, chemical absorption, optical and weathering methods, and polymers by refractomer. Operates Podbielnick low temperature automatic distillation apparatus as well as Orsat, Koppers-Hinkley, modified Koppers-Hinkley and gas blending apparatus, Infra-Red and Ultra-Violet spectrophometers, Butadiene absorber, refractometer, Carver hydraulic press, Stedman distillation bench, analytical laboratory balances, laboratory glassware, and other

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equipment to perform tasks. Makes up stock chemical solutions. Keeps accurate daily record of test data and activities. Requisitions own supplies. Maintains apparatus in suitable operating condition, and cleans equipment. Trains new technicians.

IV. Experimental Battery

All the tests of the GATB, B-1001, were administered to each sample.

V. Criteria

Sample I - California

The criterion consisted of supervisory ratings. Each worker was rated by the chief of the analytical department according to the Employee Rating Procedure (SP-1-III/7-45), and re-ratings were made two weeks later by the same person. The ratings and re-ratings were converted to numerical scores and combined. This combined score was used as the final criterion for validation purposes.

An evaluation of the criterion for this sample showed that a bias seemed to exist toward part of the sample. Of the 38 junior laboratory assistants a proportionately large number (14) was rated low and a very small number was rated high (2). Of the 44 laboratory assistants, the reverse was true; a proportionately large number (18) was rated high and a small number (5) was rated low. There seemed to be a bias resulting from the two job titles rather than just a relationship between experience and criterion, since the correlation of plant experience with the criterion (.20 with a standard error of .106) is not statistically significant.

Sample II - Michigan

The criterion consisted of rank order supervisory ratings. Each worker was rated by rank order method on job efficiency and personal acceptability. The ratings were converted to linear scores and an average of the two scores was used as the final criterion for validation purposes.

In the Polymer sample, the 36 employees were rated within their individual groups: the 18 in the Gas Laboratory were compared with each other, and the same procedure held for the two employees in the Investigational Laboratory, the four in the Physical Laboratory and the twelve in the Analytical Laboratory. This in itself may have introduced an error, since there was no way to compare the different groups; that is, all the employees in one laboratory could conceivably have exceeded all the employees in another laboratory. However, it did give a criterion that, while very limited, was as good as could be obtained.

VI. Statistical and Qualitative Analyses

The data for the two samples were analyzed separately and in combination on the basis of both statistical and qualitative considerations. Means, standard deviations, and correlations with the criterion were calculated for the aptitude scores for each sample separately. Means and standard deviations for the aptitude scores were also calculated for the Combined Sample.

A. Statistical Analysis:

Table III-A shows the means and standard deviations for the aptitudes of the GATB for each sample separately and for the combined sample. The means and standard deviations are comparable to general working population norms with a mean of 100 and a standard deviation of 20 for each aptitude.

Table III-B shows the correlations between the criterion and the aptitudes of the GATB for each sample.

TABLE III-A

Means (M) and Standard Deviations (σ) for the Aptitudes of the GATB for Each Sample Separately and for the Combined Sample

Chemist, Assistant 0-50.22

Aptitudes	California (N = 82)		Michigan (N = 36)		Combined (N = 118)	
	M	σ	M	σ	M	σ
G-Intelligence	133.3	15.5	121.6	11.0	#129.7	15.2
V-Verbal Aptitude	127.9	16.9	119.0	11.1	#125.2	15.9
N-Numerical Aptitude	127.9	14.2	122.9	10.6	#126.4	13.4
S-Spatial Aptitude	123.5	18.1	113.0	12.7	120.3	17.3
P-Form Perception	117.0	17.4	126.3	13.9	119.8	16.9
Q-Clerical Perception	121.5	17.9	119.9	13.0	121.0	16.6
A-Aiming	116.8	14.9	116.8	17.3	116.8	15.7
T-Motor Speed	115.6	16.8	105.3	16.1	112.5	17.3
F-Finger Dexterity	112.6	20.6	106.2	21.3	110.7	21.0
M-Manual Dexterity	110.7	19.4	98.3	15.8	106.9	19.3

#Relatively high mean score

TABLE III-B

Pearson Product-Moment Correlations with the Criterion for the Aptitudes of the GATB for each Sample

Chemist, Assistant 0-50.22

Aptitudes	Sample I California N = 82	Sample II Michigan N = 36
G-Intelligence	.218*	.523**
V-Verbal Aptitude	-.110	.396
N-Numerical Aptitude	.115	.226
S-Spatial Aptitude	.405**	.486**
P-Form Perception	.031	.281
Q-Clerical Perception	-.235	.103
A-Aiming	-.061	.174
T-Motor Speed	-.392**	.096
F-Finger Dexterity	.076	.111
M-Manual Dexterity	.148	.101

*Significant at the .05 level
**Significant at the .01 level

The highest mean scores for the Combined Sample, in descending order of magnitude were obtained for Aptitudes G, N, V. Aptitude N had the lowest standard deviation for the Combined Sample.

For a sample of 82 cases, correlations of .283 and .217 are significant at the .01 level and the .05 level of confidence, rsspectively. For a sample of 36 cases, correlations of .424 and .330 are significant at the .01 level and the .05 level of confidence, respectively. Aptitudes G and S show positive significant correlations with the criterion for Sample I at the .05 level and the .01 level of confidence, respectively. Aptitudes Q and T show negative significant correlations with the criterion for Sample I at the .05 level and the .01 level of confidence, respectively. There does not seem to be any logical explanation for these negative significant correlations in Sample I. Aptitudes G and S show positive significant correlations with the criterion for Sample II at the .01 level and Aptitude V at the .05 level of confidence.

B. Qualitative Analysis:

The job analysis indicated that the following aptitudes measured by the GATB appear to be important for this occupation.

Intelligence (G) - required to learn and understand fundamentals of Chemistry in order to analyze a variety of chemical compounds.

Verbal Aptitude (V) - required for facility of expression to train new technicians.

Numerical Aptitude (N) - required to calculate quantities and proportions, to measure specified quantities of materials for chemical compounds, and to perform necessary calculations with the use of a slide rule, logarithm tables or calculating machine.

Spatial Aptitude (S) and Form Perception (P) - required to fabricate, bend and shape laboratory equipment.

C. Selection of Test Norms:

Based on the quantitative and qualitative evidence cited above, Aptitudes G, V, N, and S warranted further consideration for inclusion in the test norms. The evidence for each of these aptitudes is indicated below.

Aptitude	Relatively High Mean Score	Significant Correlation with the Criterion	Importance Indicated by Qualitative Analysis
G	X	##	X
V	X	#	X
N	X		X
S		##	X

##Significant correlation with the criterion for both samples
Significant correlation with the criterion for Sample I

Although Aptitude P appeared to be important on the basis of job analysis data, it was not considered further for inclusion in the norms because there was no quantitative evidence of significance.

Various combinations of Aptitudes G, V, N, and S, with appropriate cutting scores were selected as trial norms. The relationship between each set of trial norms and the criterion (dichotomized as indicated in Section VII) was determined for each sample separately and for the combined sample.

A comparison of the results showed that the relationship between B-1001 norms consisting of G-115, V-110, N-110, and S-105 and the criterion for each sample taken separately was not significant, however, a significant relationship for these norms was obtained for the combined sample.

In test development studies an attempt is made to develop a set of norms such that the cutting score for each aptitude included in the norms will be set at a five-point score level close to one standard deviation below the aptitude mean of the experimental sample. Adjustments of cutting scores from one standard deviation below the mean are made to effect better selective efficiency of the norms. In this study the aptitude cutting scores are each within 16 points of one standard deviation below the aptitude mean of the sample of the combined sample.

VII. Concurrent Validity of Norms

For the purpose of computing the tetrachoric correlation coefficient between the test norms and the criteria and applying the Chi Square test, the criteria for the two samples were dichotomized. The criterion for each sample was dichotomized at the point which resulted in as close to one third of the sample as possible being placed in the low criterion group. This was accomplished by setting a criterion critical score of 46 for Sample I and 44 for Sample II.

Tables IV-A and IV-B show the relationship between test norms consisting of Aptitudes G, V, N, and S with minimum scores of 115, 110, 110, and 105, respectively, and the dichotomized criteria for Sample I and Sample II, respectively. Table IV-C which is a composite of Tables IV-A and IV-B, shows the selective efficiency of the norms for the Combined Sample. Workers in each high criterion group have been designated as "good workers" and those in each low criterion group as "poor workers".

TABLE IV-A

Relationship between Test Norms Consisting of
Aptitudes G, V, N, and S with Critical Scores of 115, 110, 110, and 105,
Respectively, and the Criterion for Sample I

Chemist, Assistant 0-50.22
N = 82

	Non-Qualifying Test Scores	Qualifying Test Scores	Total
Good Workers	14	49	63
Poor Workers	8	11	19
Total	22	60	82

$r_{tet} = .35$ $\quad X^2 = 2.014$

$\sigma_{r_{tet}} = .20$ $\quad P/2 < .10$

The data in the above table indicate that the relationship between the test norms and the criterion for Sample I was not significant.

TABLE IV-B

Relationship between Test Norms Consisting of Aptitudes G, V, N, and S with Critical Scores of 115, 110, 110, and 105, Respectively, and the Criterion for Sample II

Chemist, Assistant 0-50.22
N = 36

	Non-Qualifying Test Scores	Qualifying Test Scores	Total
Good Workers	9	12	21
Poor Workers	9	6	15
Total	18	18	36

r_{tet} = .27 X^2 = .457

$\sigma_{r_{tet}}$ = .26 P/2 < .25

The data in the above table indicate that the relationship between the test norms and the criterion for Sample II was not significant.

TABLE IV-C

Relationship between Test Norms Consisting of Aptitudes G, V, N, and S with Critical Scores of 115, 110, 110, and 105, Respectively, and the Criterion for the Combined Sample

Chemist, Assistant 0-50.22
N = 118

	Non-Qualifying Test Scores	Qualifying Test Scores	Total
Good Workers	23	61	84
Poor Workers	17	17	34
Total	40	78	118

r_{tet} = .37 X^2 = 4.563

$\sigma_{r_{tet}}$ = .16 P/2 < .025

The data in the above table indicate a significant relationship between the test norms and the criteria for the Combined Sample.

IX. Determination of Occupational Aptitude Pattern

When the specific test norms for an occupation include four aptitudes, only those occupational aptitude patterns which include three of those four aptitudes with cutting scores that are within 10 points of the cutting scores established for the specific norms are considered for that occupation. Three of the existing 23 occupational aptitude patterns meet these criteria for this study. These occupational aptitude patterns and their B-1001 norms are OAP-1 (G-115, V-105, N-110), OAP-4 (G-110, N-100, S-100) and OAP-18 (G-105, V-100, S-95). The selective efficiency of each of these OAP's for this sample was determined by means of the tetrachoric correlation technique. No significant relationship was obtained between OAP-1, OAP-4, and the dichotomized criterion. For OAP-18, a tetrachoric correlation of .46 with a standard error of .18 was obtained. This indicates a significant relationship between OAP-18 and the criterion for the experimental sample. The proportion of the sample screened out by OAP-18 was .16, which is within the required range of .10 to .60. Therefore, OAP-18 is recommended for use in counseling for the occupation of Chemist, Assistant 0-50.22.